WAVELENGTH RANGE

The MV model of the SPECTRONIC 21 series, shown in Figure 1, uses a tungsten lamp to provide an uninterrupted wavelength range of 340-1000nm.

READOUT

The 5½″ meter is mirrored to prevent parallax error, is linear in transmittance, and is also calibrated in absorbance. The meter scale reads from 00.0 to 100% transmittance with linear scale divisions at every 1% transmittance. An analog output permits the use of recording devices to record results in percent transmittance.

ACCESSORIES SUPPLIED

The instrument is supplied complete with:

1. Universal test tube holder
2. Spare tungsten lamp
3. One dozen 10mm pathlength test-tube cuvettes
4. Operator's manual
5. Dust cover
6. Calibration screwdriver
7. Occluder block
8. Adapter for rectangular cuvettes

SPECIFICATIONS

Wavelength Range	340-1000nm
Wavelength Accuracy	Better than 2nm at 365nm and 546nm
Wavelength Readability	1.0nm
Wavelength Repeatability	Better than 1nm
Spectral Slitwidth	10nm
Stray Radiant Energy	0.05% (typical) at 340nm
Photometric Readout	5½″ meter, linear transmittance (T), non-linear absorbance (A), mirrored scale
Photometric Range	0-100%T, 0-2A
Photometric Noise	Less than 0.1%T near 100%T
Photometric Linearity	Better than 1.0%T at meter Better than 0.2%T at analog output
Photometric Accuracy	Better than 0.3%T at analog output
Long-term Drift	0.003A per hour
Zero Drift	Less than 0.1%T per day
Accessory Output	Analog in %T, 1 volt (adjustable)
Dispersing Element	Reflection grating, 1200 lines/mm
Power Consumption	40 Watts
Voltage Requirements	Selectable: 100V, 115V, 220V, 240V; 50, 60 Hz
Size	14½″ W x 10½″ D x 8½″ H (36.8cm W x 26.7cm D x 21.6cm H) Add 5½″ (14cm) to width for General Purpose Sample Compartment.
Weight	16 lbs. (7.3kg) Add 3½ lbs. (1.6kg) for General Purpose Sample Compartment.

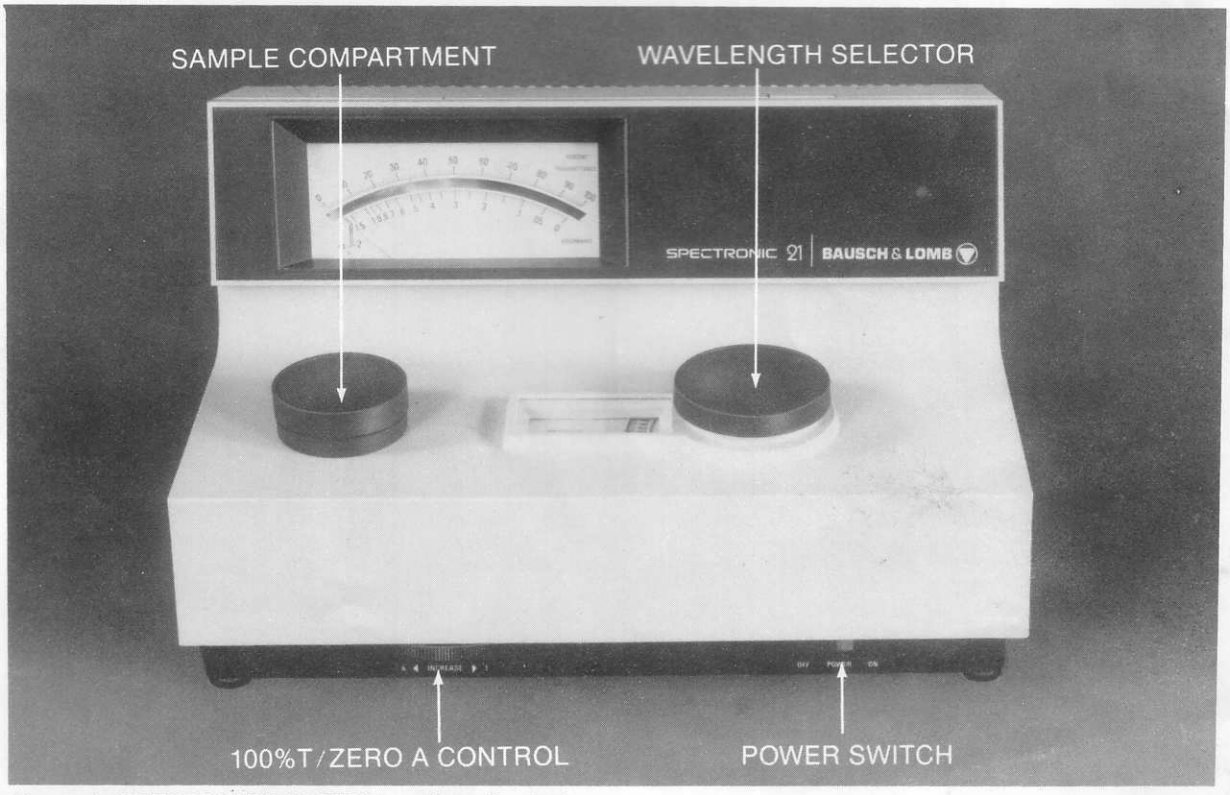


Figure 1. SPECTRONIC 21 MV Operating Controls

Power Consumption	45 Watts
Voltage Requirements	Selectable: 100V, 115V, 220V, 240V; 50, 60 Hz
Size	14½" W x 10½" D x 8½" H (36.8cm x 26.7cm x 21.6cm) Add 5½" (14cm) to width for General Purpose Sample Compartment
Weight	16½ lbs. (7.5kg) Add 3½ lbs. (1.6kg) for General Purpose Sample Compartment

OPERATING PROCEDURES

Before using the instrument, check the electronic calibration as described in the Maintenance section.

NOTE

The instrument is set to operate on a 115VAC line. If this voltage is not correct for your line, see the Voltage Conversion instructions in the Maintenance section.

Operating controls are shown in Figure 2.

1. Plug the instrument into a grounded outlet.
2. Turn the instrument on using the POWER switch on the right side of the lower control panel. Although the instrument can be used almost as soon as it is turned on, best performance is achieved following a warmup period of 15 to 30 minutes.

NOTE

Display may be slow to turn on, or may have unusual characters during first minute of operation. This is normal.

3. Select the desired wavelength with the wavelength selector. Wavelength is indicated on the dial located to the left of the wavelength selector.
4. Choose matched cuvettes of the appropriate pathlength for the analytical method. Use the sample pathlength cuvettes for all blanks, standards, and samples.
5. Open the sample compartment door.
6. Fill one cuvette with a blank solution and insert it in the sample compartment. Fill the cuvette with enough solution to completely cover the light beam passing through the sample compartment. Some cuvettes are provided with a horizontal fiducial mark to indicate the proper fill level. A vertical fiducial mark on the cuvette is provided for alignment with the mark on the sample compartment.

NOTE

a. Solution level must be at least 20 mm high in a standard cuvette (10 cm square; used with cuvette adaptor).

b. Solution level must be at least 32 mm high in a test tube cuvette (used with universal test tube holder).

7. Close the sample compartment cover.
8. Select the operating mode—transmittance, absorbance, or concentration—using the mode selector.
9. Set the SENSITIVITY switch located in the center of the lower control panel to LO.
10. SET 100%T, 000A, or 000C for the blank using the 100%T/zero A control located on the left side of the lower control panel. If there is not enough energy to set 100%T, 000A or 000C on the blank, move the SENSITIVITY switch to the M (medium) or, if necessary, to the HI position. Any position at which 100%T can be set is acceptable. (The SENSITIVITY switch is a coarse adjustment for the 100%T/zero A control.) Be sure to reset the 100%T/zero A control each time that you reset the SENSITIVITY switch.
11. Remove the blank.
12. Fill each of the matched cuvettes with the standard solution or sample to be measured. Proceed to step 13 under the heading appropriate to the mode you are using.

Absorbance or Transmittance Mode

13. Turn MODE SELECTOR to absorbance or transmittance and insert each sample or standard solution, in turn, into the sample compartment, reading the recording absorbance or transmittance values. (For most analytical purposes absorbance values are more linear than transmittance values and can be more conveniently utilized.)
14. Construct a standard curve by plotting the absorbance on the y-axis vs. the concentration of each standard solution on the x-axis.
15. Determine the concentration of each sample by finding the absorbance or transmittance value on the y-axis and reading the corresponding concentration value off the x-axis.
16. Correct for any sample blank or interference effects as necessary.

Concentration Mode (use only if the linearity of the standard curve has be verified).

13. Turn MODE SELECTOR to concentration. Place a standard solution in the sample compartment.
14. Using the CONC. ADJUST control, set the concentration value of the standard on the digital display. Repeat with other standard solutions for verification. The CONC. FACTOR CHECK button can be depressed to check and record test conditions (see Appendix A).
15. Insert samples in the sample compartment and read results directly in concentration units.
16. The decimal select feature permits selection of 3, 2, 1, or 0 decimal places on the digital display. The feature operates in the concentration mode only and is controlled by the DECIMAL SELECT pushbutton at the left of the digital display:

    Each time the pushbutton is pressed, the decimal point moves one place to the right on the display until the zero decimal place is reached (the decimal point disappears). Pressing the pushbutton once more returns the decimal point to the third place.

    If the pushbutton is pressed while the instrument is in the transmittance or absorbance mode, it has no effect. When the instrument is switched back to the concentration mode, the previous concentration decimal setting will still be in effect. If the instrument is turned off, turning it back on resets the decimal point to the zero decimal position (no point visible).

SPECTRONIC 21 UVD SPECTROPHOTOMETER

WAVELENGTH RANGE

The UVD model of the SPECTRONIC 21 series, shown in Figure 3, has an external lamp house, containing both the tungsten and deuterium lamps which provide a wavelength range of 200-1000nm.

READOUT

The digital display lets you read in any of three operating modes: transmittance, absorbance, or concentration. A three-position SENSITIVITY switch and the 100%T/zero A control let you select the desired instrument gain setting. For values outside the photometric range, the left-hand digit position will display a "u" for underrange or an "o" for overrange.

The concentration mode yields results directly in concentration units. A CONC. FACTOR CHECK button provides a readout of the concentration factor when in the concentration mode.

ACCESSORIES SUPPLIED

The instrument is supplied complete with:

1. Universal test tube holder
2. Spare tungsten lamp
3. One dozen 10mm pathlength test tube cuvettes
4. Operator's manual
5. Dust cover
6. Calibration screwdriver
7. Occluder block
8. Adapter for rectangular cuvettes

SPECIFICATIONS

Wavelength Range	200-1000nm
Wavelength Accuracy	Better than 2nm at 254nm, 365nm, and 546nm
Wavelength Readability	Better than 1.0nm
Spectral Slitwidth	10nm
Stray Radiant Energy	0.05% (typical) at 340nm
Photometric Readout	Digital display, selectable for transmittance (T), absorbance (A), or concentration (C), and A to C conversion factor (concentration factor)
Photometric Range	00.0-100.0 in T 0.000-1.990 in A 000-1990 in C
Photometric Noise	Less than 0.1 near 100%T 0.001 near 0.00A 0.002 near 1.00A
Photometric Linearity	Better than 0.2%T (0.002A at 0.4A)
Photometric Accuracy	Better than 0.3%T (0.003A at 0.4A)
Long-term Drift	0.003A per hour
Zero Drift in Transmittance (T)	Less than 0.1% per day
Accessory Output	Analog in %T, 1 Volt (adjustable), BCD, TTL Positive True Logic
Monochromator	Crossed Czerny-Turner
Dispersing Element	Reflection grating, 1200 lines/mm
Power Consumption	60 Watts
Voltage Requirements	Selectable: 100V, 115V, 220V, 240V; 50, 60 Hz
Size	20″ W x 10½″ D x 8½″ H (50.8cm x 26.7cm x 21.6cm). Add 5½″ (14cm) to width for General Purpose Sample Compartment

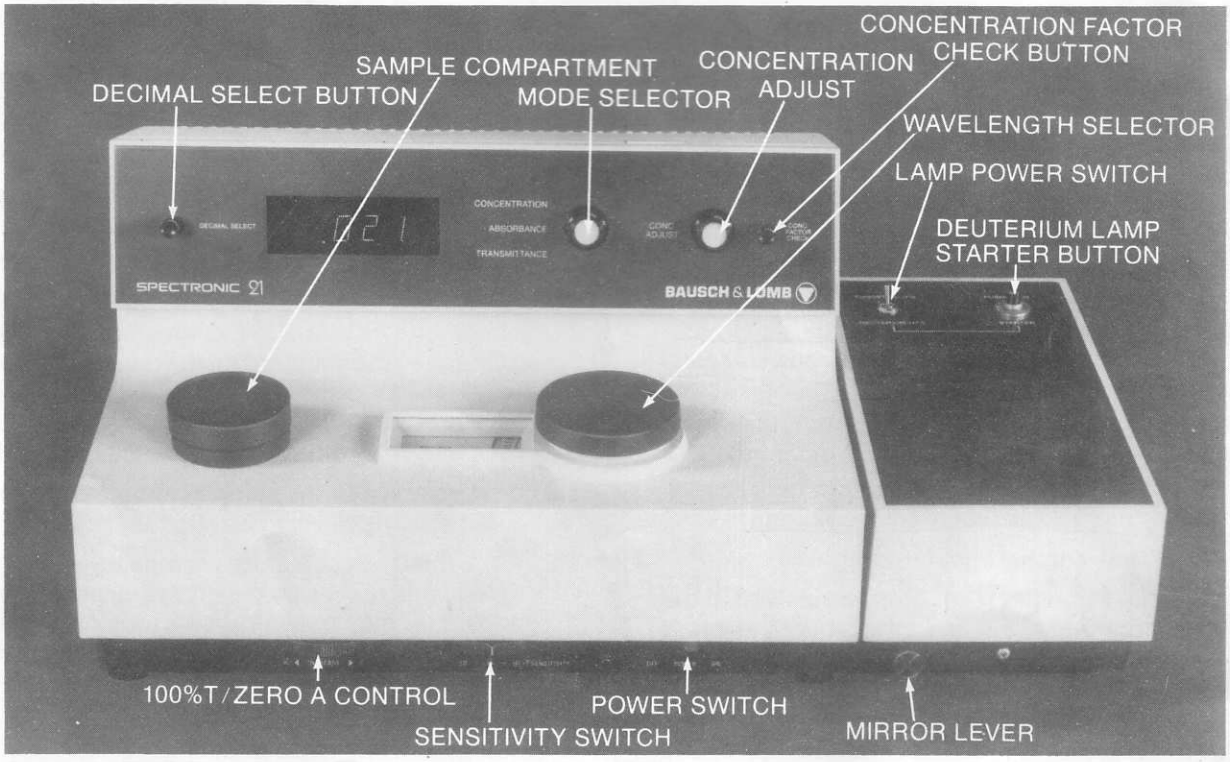


Figure 3. SPECTRONIC 21 UVD Operating Controls

Weight	22½ lbs. (10.2kg). Add 3½ lbs. (1.6kg) for General Purpose Sample Compartment

OPERATING PROCEDURES

Before using the instrument, check the electronic calibration as described in the Maintenance section.

NOTE

The instrument is set to operate on a 115 VAC line. If this voltage is not correct for your line, see the Voltage Conversion instructions in the Maintenance section.

Operating controls are shown in Figure 3.

1. Plug the instrument into a grounded outlet.
2. Turn the instrument on, using the POWER switch on the right side of the lower control panel. Although the instrument can be used almost as soon as it is turned on, best performance is achieved following a warm-up of 15 to 30 minutes.
3. Select the desired wavelength with the wavelength selector. Wavelength is indicated on the dial located to the left of the wavelength selector. Wavelength may be set in the range 200-1000nm.
4. Adjust the mirror position for the lamp required by pulling the mirror lever out when using the deuterium lamp (UV) and pushing the mirror lever in when using the tungsten lamp (VIS).
5. Choose the correct lamp for the selected wavelength by flipping the lamp power switch to TUNGSTEN-VIS or DEUTERIUM-UV.
6. Ignite the deuterium lamp by pushing the STARTER button for approximately 2 seconds and releasing. The deuterium lamp requires a warm-up of at least 10 minutes before readings are taken. Maximum lamp stability takes longer.

   The portion of the wavelength dial marked with a red line indicates that the tungsten lamp should be used. The portion of the wavelength dial marked with a blue line indicates that the deuterium lamp should be used. The portion of the wavelength dial marked with alternate red and blue marks indicates that the lamp which provides the most energy (gives the highest %T when no sample is in place) should be used.
7. Choose matched cuvettes of the appropriate pathlength for the analytical method. Use the same pathlength cuvettes for all blanks, standards, and samples.

NOTE

The glass test tubes supplied with the instrument are usable only above 325nm. Quartz or "fused silica" cuvettes must be used below 325nm.

8. Open the sample compartment door.
9. Fill one cuvette with a blank solution and insert it in the sample compartment. Fill the cuvette with enough solution to completely cover the light beam passing through the sample compartment. Some cuvettes are provided with a horizontal fiducial mark to indicate the proper fill level. A vertical fiducial mark on the cuvette is provided for alignment with the mark on the sample compartment.

NOTE

a. Solution level must be at least 20 mm high in a standard cuvette (10 cm square; used with cuvette adaptor).
b. Solution level must be at least 32 mm high in a test tube cuvette (used with universal test tube holder).

10. Close the sample compartment cover.
11. Select the operating mode—transmittance, absorbance, or concentration—using the mode selector.
12. Set the SENSITIVITY switch located in the center of the lower control panel to LO.
13. Set 100%T, 000A, or 000C for the blank using the 100%T/zero A control located on the left side of the lower control panel. If there is not enough energy to set 100%T, 000A, or 000C on the blank, move the SENSITIVITY switch to the M (medium) or, if necessary, to the HI position. Be sure to reset the 100%T/zero A control each time that you reset the SENSITIVITY switch.
14. Remove the blank.
15. Fill each of the matched cuvettes with the standard solution or sample to be measured. Proceed to step 16 under the heading appropriate to the mode you are using.

Absorbance or Transmittance Mode

16. Turn MODE SELECTOR to absorbance or transmittance and insert each sample or standard solution, in turn, in the sample compartment, reading and recording absorbance or transmittance values. (For most analytical values absorbance values are more linear than transmittance values and can be more conveniently utilized.)
17. Construct a standard curve by plotting the absorbance on the y-axis vs. the concentration of each standard solution on the x-axis.
18. Determine the concentration of each sample by finding its absorbance value on the y-axis and reading the corresponding concentration value off the x-axis.
19. Correct for any sample blank or interference effects as necessary.

Concentration mode (to be used only if the linearity of the standard curve has been verified).

16. Turn MODE SELECTOR to concentration. Place the standard solution in the sample compartment.
17. Using the CONC. ADJUST control, set the concentration value of the standard on the digital display. Repeat this step with other standards for verification. The CONC. FACTOR CHECK button can be depressed to check and record test conditions (see Appendix A).
18. Insert samples in the sample compartment and read results directly in concentration units.
19. The decimal select feature permits selection of 3, 2, 1, or 0 decimal places on the digital display. The feature operates in the concentration mode only and is controlled by the DECIMAL SELECT pushbutton at the left of the digital display.

    Each time the pushbutton is pressed, the decimal point moves one place to the right on the display until the zero decimal place is reached (the decimal point disappears). Pressing the pushbutton once more re-

turns the decimal point to the third place.

If the pushbutton is pressed while the instrument is in the transmittance or absorbance mode, it has no effect. When the instrument is switched back to the concentration mode, the previous concentration decimal setting will still be in effect. If the instrument is turned off, turning it back on resets the decimal point to the zero decimal position (no point visible).

MAINTENANCE

SCOPE OF OPERATOR MAINTENANCE

This section describes all maintenance procedures that should be performed by the operator. All other maintenance, trouble-shooting, or repair tasks should be performed only by an authorized service representative.

TROUBLESHOOTING

Table 1 presents the probable causes and remedies for most operating and instrument problems. If you encounter a problem that the table does not enable you to diagnose, call an authorized service representative.

Table 1. Operator Troubleshooting Chart

Problem	Possible Cause	Remedy
Instrument inoperative.	Line cord not connected to outlet.	Plug instrument in.
	Dead power outlet.	Change to different outlet.
	Internal fuse blown.	Call an authorized service representative.
	Defective electronic component.	Call an authorized service representative.
Cannot set 100%T (.000A) with no sample in sample holder.	Light beam blocked.	Check sample compartment.
	Wrong source lamp for wavelength being used (UV model).	Check lever position for lamp being used. Lever should be pushed in for visible range and pulled out for UV range.
	Wrong line voltage.	
	Source lamp not adjusted (UV model).	Refer to Lamp Alignment procedures.
	Source lamp defective or old.	Refer to Lamp Replacement procedures.
	Defective electronic component.	Call an authorized service representative.
T cannot be set to 00.0% with occluder block in sample holder.	Sample compartment drain hole or port cover not closed.	Close covers.
	Instrument out of electronic calibration.	Refer to Electronic Calibration procedure.
	Defective electronic component.	Call an authorized service representative.
Instrument drift and noise.	Excessive line voltage variation.	Check line voltage and grounding.
	Incorrect voltage selector switch setting.	Refer to Voltage Conversion Procedure.
	Source lamp defective or old.	Replace with appropriate lamp.
	Bubbles or particles in solution.	Check sample preparation and analytical procedure.
	Source lamp not adjusted (UV model).	Refer to Lamp Alignment procedure.
	Defective or dirty detector.	Refer to Detector Maintenance procedure.
	Defective electronic component.	Call an authorized service representative.

Table 1. (Con't)

Problem	Possible Cause	Remedy
Incorrect transmittance-to-absorbance correlation.	Instrument out of electronic calibration.	Refer to Electronic Calibration procedure.
	Defective electronic component.	Call an authorized service representative.
Digital display does not change regardless of instrument settings.	Instrument out of calibration.	Refer to Electronic Calibration procedure.
	Defective electronic component.	Call an authorized service representative.
Incorrect reading obtained.	Stray sample preparation vapors.	Prepare samples away from instruments; use proper ventilation.
	Insufficient sample volume.	Fill cuvette with greater sample volume.
	Bubbles or particles in solution.	Check sample preparation and analytical procedure.
	Wrong wavelength setting.	Check analytical procedure and wavelength setting.

VOLTAGE CONVERSION

1. Turn off and unplug the instrument.
2. Tilt the instrument onto its back for access to the voltage selector switch, located on the underside of the instrument base.
3. Refer to Figure 4. Remove the voltage selector switch cover (mounted with two holding screws).

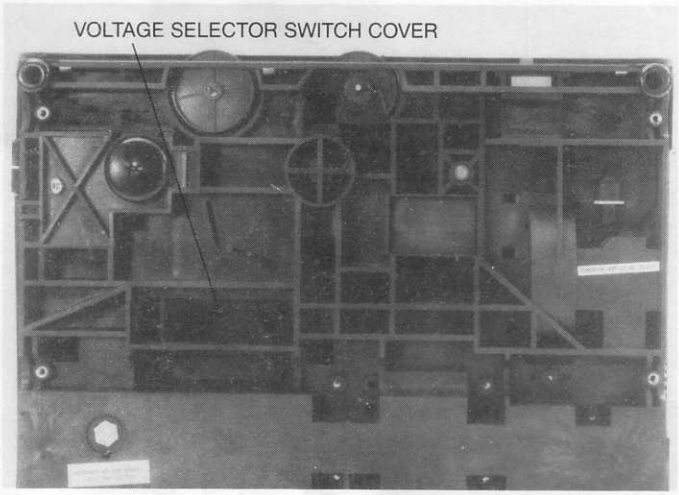


Figure 4. Location of Voltage Selector Switch

4. Refer to Figure 5. Loosen the locking nuts one turn each.

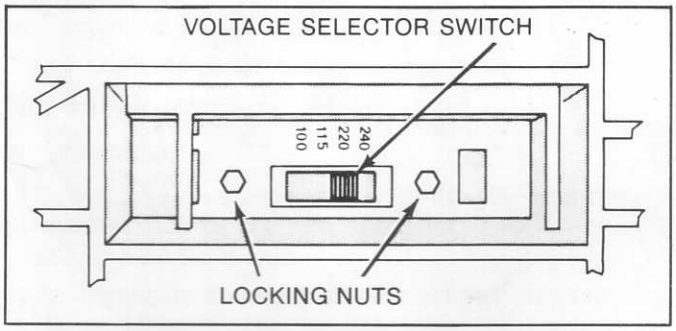


Figure 5. Voltage Selector Switch

5. Set the voltage selector switch at the desired voltage (100, 115, 220, or 240 VAC).
6. Retighten the locking nuts.
7. Replace the voltage selector switch cover and tighten the two holding screws.

TUNGSTEN LAMP REPLACEMENT

Models MV and DV

1. Turn off and unplug the instrument.
2. Tilt the instrument onto its back for access to the lamp housing, located in the upper right corner of the instrument base.

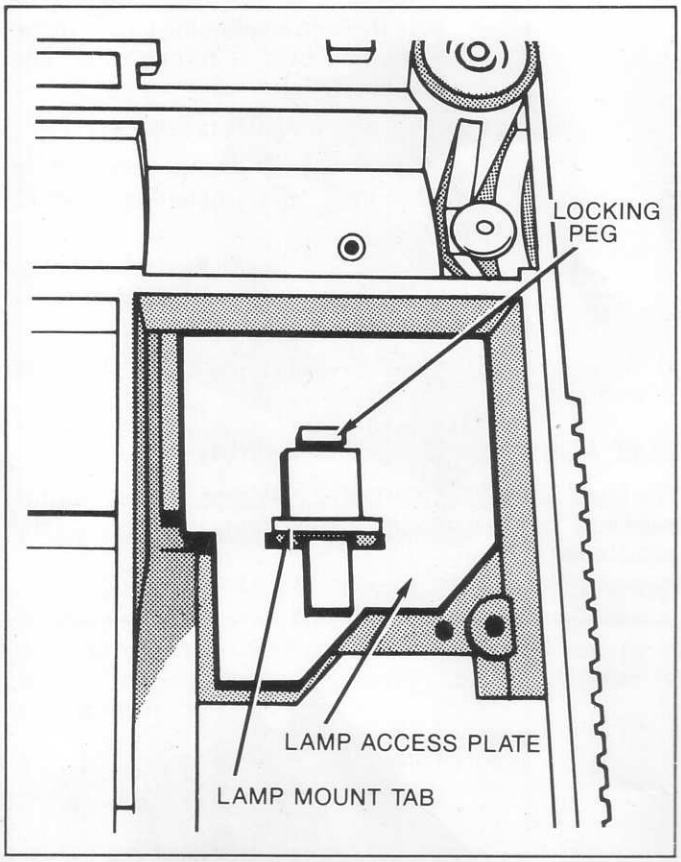


Figure 6. Exterior of Lamp Housing on Model MV or DV

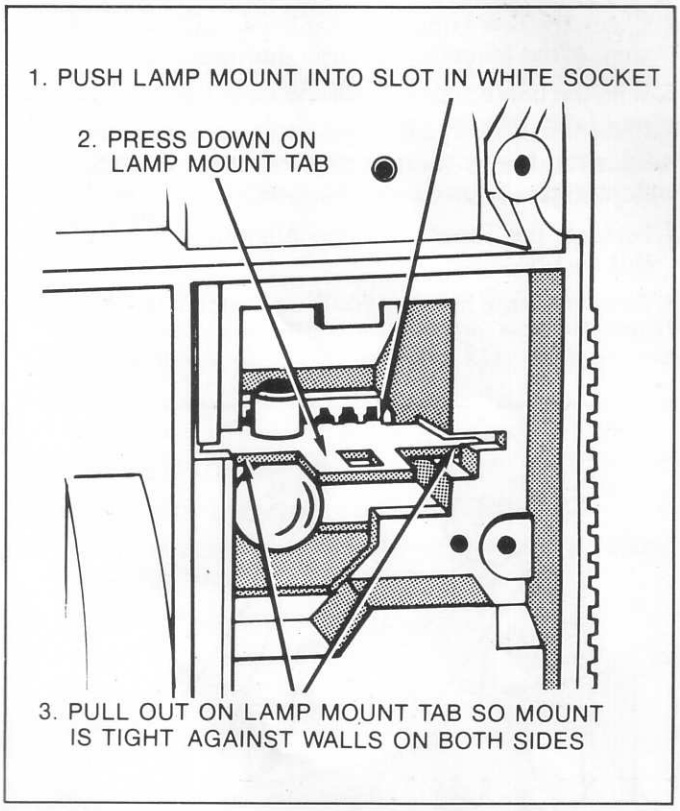

1. PUSH LAMP MOUNT INTO SLOT IN WHITE SOCKET
2. PRESS DOWN ON LAMP MOUNT TAB
3. PULL OUT ON LAMP MOUNT TAB SO MOUNT IS TIGHT AGAINST WALLS ON BOTH SIDES

Figure 7. Installation of Lamp in Model MV or DV

3. **Refer to Figure 6. Lift the locking peg out of the lamp mount tab (pry gently with a screwdriver, if necessary). Pull the lamp access plate off.**
4. Grasp the lamp mount tab and raise the lamp mount so its edges are aligned with the slots in the base. Pull the lamp mount out through the slots.
5. Check the new lamp for cleanliness and wipe it if necessary. Avoid touching the lamp during installation.
6. **Refer to Figure 7. Slide the new lamp assembly into the housing and push the plated end of the lamp mount into the socket at the rear of the lamp housing.**
7. Press the lamp mount tab down, then pull forward on the tab until the front edge of the mount is tight against the walls on both sides.
8. To replace the access plate, hook the tab which is on the inner surface of the access plate under the tab at the top of the housing, and press the plate into place. Slide the plate as far to the right as possible.
9. Insert the locking peg into the eye on the lamp access plate. Slide the peg down through the lamp mount tab until the peg is snug.

NOTE

When properly installed, the tip of the peg is visible on the *outside* of the lamp access plate. If not, remove the plate and go back to step 5.

Model UVD

1. Turn off and unplug the instrument.
2. Refer to Figure 8. Loosen the clamping screw on the **front of the lamp housing base two full turns. Lift the lamp housing cover open.**
3. Unscrew and remove the knurled thumbscrew securing the tungsten lamp mount. Slide the lamp mount off the two locating pins. Grasp the socket and pull the lamp mount to remove the old lamp assembly.

CAUTION

Do not pull on the wires.

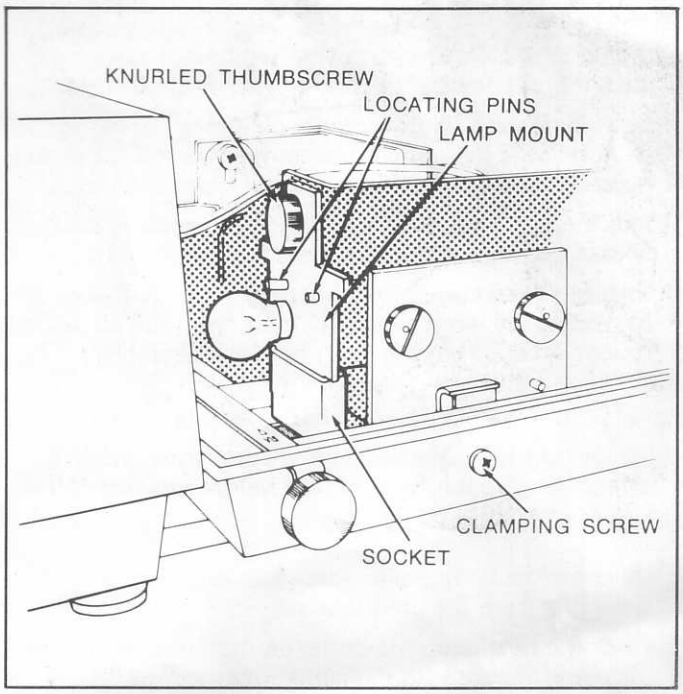


Figure 8. Tungsten Mounting in Model UVD

4. Check the new lamp for cleanliness and wipe if necessary. Avoid touching the lamp during installation.
5. With the contact aligned as shown in Figure 9, plus the new lamp into the socket.
6. Slide the lamp mount onto the two locating pins. Replace the knurled thumbscrew.
7. Perform the Tungsten Lamp Alignment procedure in this section.
8. Close the lamp housing cover and tighten the clamping screw.

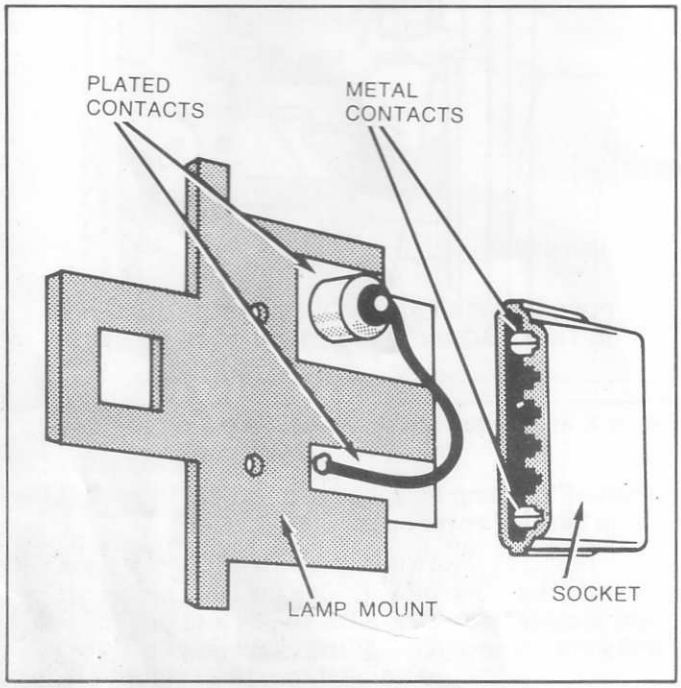


Figure 9. Alignment of Tungsten Lamp Mount and Socket in Model UVD

DEUTERIUM LAMP REPLACEMENT (MODEL UVD ONLY)

1. Turn off and unplug the instrument.
2. Refer to Figure 10. Loosen the clamping screw on the front base of the lamp house cover two full turns and open cover.
3. Pull the lamp wires off the spade connectors located behind the lamp mounting plate (see Figure 11).
4. Unscrew the knurled thumbscrew, shown in Figure 10, to release the lamp mounting plate from the adjusting bracket and lift out the lamp bracket assembly.

CAUTION

Do not touch the lamp envelope. Any fingerprints on the lamp should be removed before ignition of the lamp or they will be baked on.

5. Unscrew the lamp collar screws to remove the lamp assembly from the mounting plate.
6. Place the new lamp assembly on the lamp mounting plate and secure with the lamp collar screws.
7. Place the lamp mounting plate against the adjusting bracket, making sure the bottom aligning post is in the slot, and the top aligning post is through the hole provided on the mounting plate.
8. Replace and tighten the knurled thumbscrew.
9. Place the lamp wires over the spade connectors located behind the mounting plate, matching colors as indicated on the label.
10. Be sure the lamp is properly aligned (see Lamp Alignment procedure in this section) and completely free of dust and fingerprints.
11. Close the lamp house cover and tighten the clamping screw.

LAMP ALIGNMENT (MODEL UVD ONLY)

The lamp in the SPECTRONIC 21 MV and DV spectrophotometers is self-aligning and requires no special adjustment.

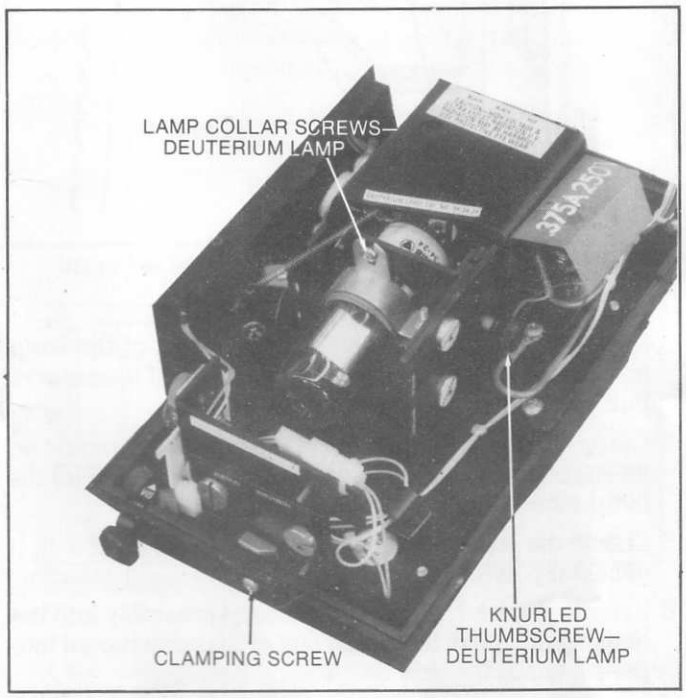


Figure 10. Deuterium Lamp Mounting

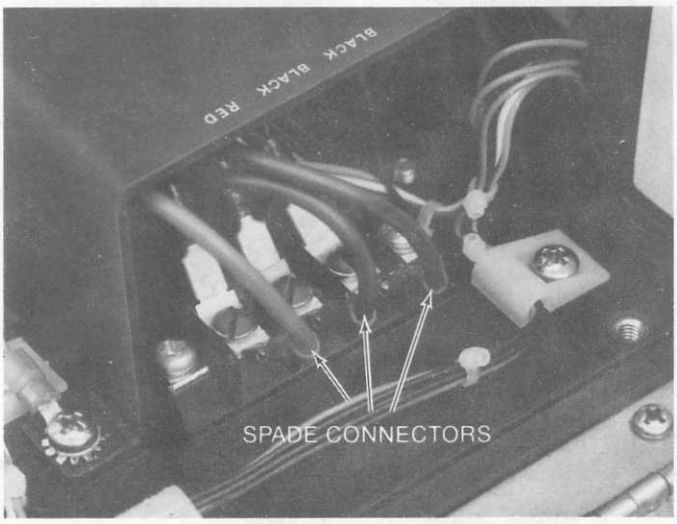


Figure 11. Deuterium Lamp Spade Connectors

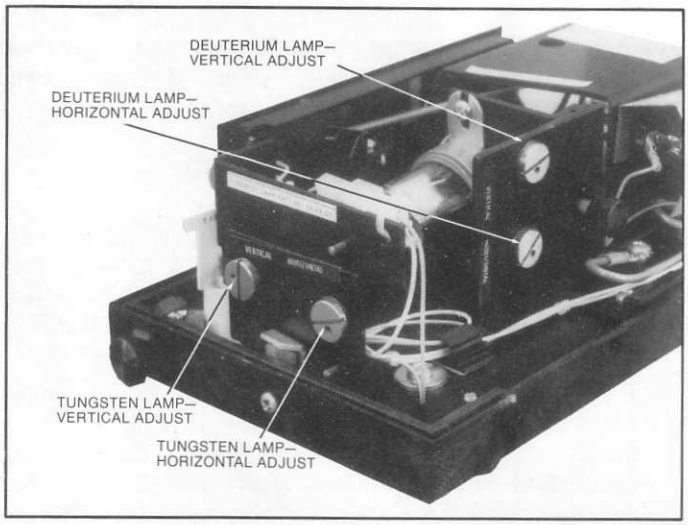


Figure 12. Lamp Alignment Adjustments

In a Model UVM or UVD, lamp aligment must always be done when a lamp assembly is replaced, and should also be checked in cases of reduced lamp energy or excess noise. Refer to Figure 12 for location of adjustments.

Tungsten Lamp Alignment

1. Turn the instrument on.
2. Set the lamp power switch to TUNGSTEN-VIS.
3. Push the mirror lever all the way in for the visible range.
4. Loosen the clamping screw on the front base of the lamp house cover two full turns and open the cover.
5. Using the wavelength selector, set the wavelength to 450nm.
6. Set the mode selector to TRANSMITTANCE.
7. Close the sample compartment covers.
8. Rotate the 100%T/zero A control to set a convenient transmittance reading around 50%T.
9. Using the eccentric screws on the tungsten lamp adjusting bracket, adjust the position of the lamp to obtain a maximum transmittance reading as follows:

   By turning the left screw, move the lamp assembly vertically to obtain a maximum transmittance readout. By turning the right screw, move the lamp assembly horizontally to obtain a maximum transmittance readout.
10. Repeat left and right screw adjustments until a maximum transmittance value is obtained. It may be necessary during this procedure to adjust the 100%T/zero A control (step 8) to reset a convenient, observable transmittance reading.
11. Close the lamp house cover and tighten the clamping screw.

Deuterium Lamp Alignment

WARNING

There are dangerous high voltages within this equipment. When the lamp house cover is removed, utmost care should be used in this procedure since the power must remain on.

WARNING

Use safety glasses. Do not look directly at the deuterium lamp during operation. Eye damage may result.

1. Turn the instrument on.
2. Set the lamp power switch to DEUTERIUM-UV.
3. Ignite the deuterium lamp by depressing the starter button for approximately two seconds.
4. Set the mirror lever to the UV position.
5. Loosen the clamping screw on the front base of the lamp house cover two full turns and open cover.
6. Using the wavelength selector, set the wavelength to 240nm.
7. Set the mode selector to TRANSMITTANCE.
8. Close the sample compartment cover.
9. Rotate the 100%T/zero A control to set a convenient transmittance reading around 50%T.
10. Using the eccentric screws on the deuterium lamp adjusting bracket, adjust the position of the lamp to obtain a maximum transmittance value as follows:

    Adjust the screws to the position shown in Figure 12. By turning the upper screw, move the lamp assembly vertically to obtain a maximum transmittance readout. By turning the lower screw, move the lamp assembly horizontally to obtain a maximum transmittance readout.
11. Repeat upper and lower screw adjustments until a maximum transmittance value is obtained. It may be necessary during the procedure to adjust the 100%T/zero A control (Step 9) to reset a convenient, observable transmittance reading.
12. Close the lamp house cover and tighten the clamping screw.

DETECTOR MAINTENANCE

Low energy or the inability to set 100%T or zero A may indicate the need for cleaning or replacing the detector.

1. Turn off and unplug the instrument.
2. Tilt the instrument onto its back for access to the bottom.

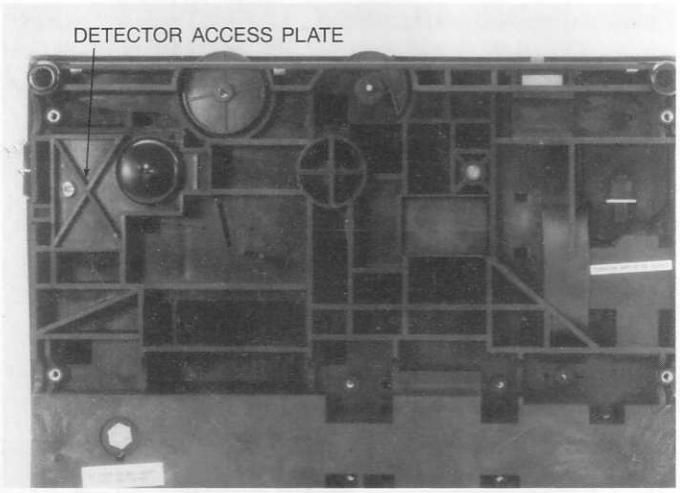


Figure 13. Location of Detector Access Plate

3. Remove the detector access plate (shown in Figure 13) by removing the holding screw and lifting the tab on the left.
4. Grasp the detector mounting board and pull it out through the aligning slots. If pliers are used, pull directly below the socket and only contact the mounting board on the very edge to avoid damaging metal runs or components.
5. Inspect the silicon chip for dirt and fingerprints. If necessary, clean gently with a cotton swab which has been dipped in methyl alcohol.
6. Insert the cleaned detector or insert a new detector by grasping the mounting board and inserting it through the aligning slot (as shown in Figure 14). Be sure the silicon detector faces toward the light source and that the white plastic terminal properly engages the connectors located in the instrument.
7. Replace the detector access plate and secure with the holding screw.

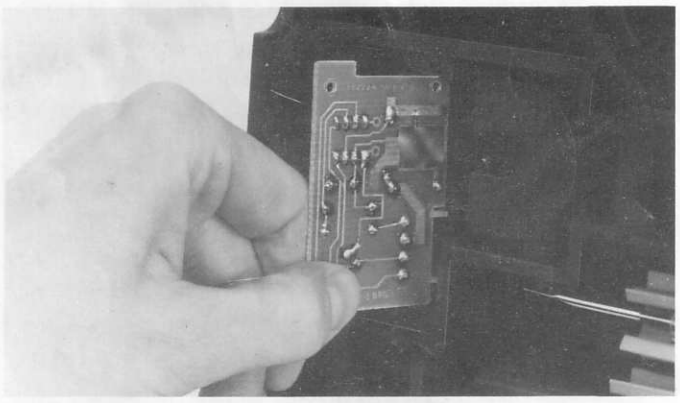


Figure 14. Detector Replacement

ELECTRONIC CALIBRATION

The spectrophotometer has been factory-calibrated and does not require periodic calibration. Calibration should be performed only when results lead you to believe it is necessary.

In the following procedures, an accuracy of ±1 digit is adequate for most applications.

Before calibrating, turn the spectrophotometer on and let it warm up for at least 30 minutes.

On digital models (DV or UVD) perform all three of the following calibration procedures in the order given. On the meter model (MV) only the 0%T Calibration procedure can and should be used.

Absorbance-to-Transmittance Calibration (Digital Models Only)

1. Set the wavelength dial to approximately 340nm. Set the mode selector to TRANSMITTANCE. With the 100%T/zero A control, set the spectrophotometer display to read 39.9. (If necessary, change the setting of the SENSITIVITY switch.)
2. Turn the mode selector to ABSORBANCE. Use a screwdriver to pry off the small access plate on top of the spectrophotometer control panel. Turn the A calibration adjustment (shown in Figure 15) until the display reads .399.

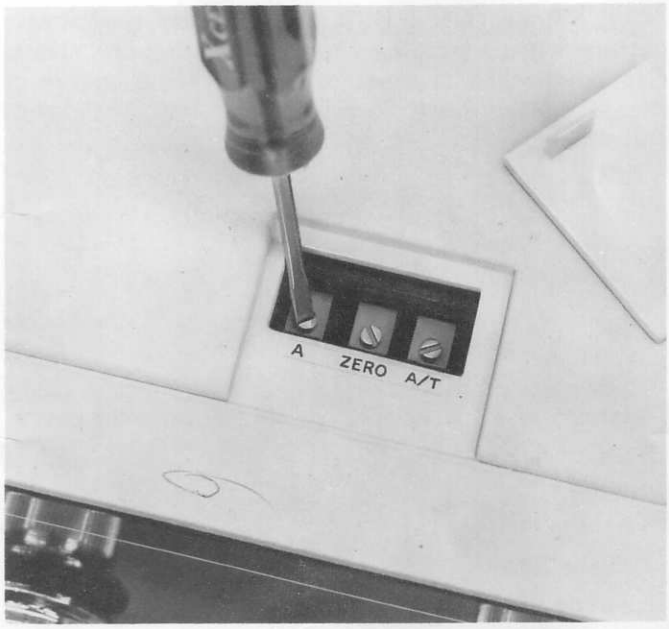


Figure 15. Location of Absorbance-to-Transmittance Calibration Adjustments

3. Switch back to the transmittance mode. The display should still read 39.9.
4. If necessary, repeat steps 1 through 3 until the correct reading in step 3 is obtained. If there is substantial disagreement between the transmittance and absorbance readings, the following procedure will most rapidly bring the readings into agreement.
   a. In step 2, note the amount of difference between the absorbance and transmittance readings. Turn the A calibration adjustment to reduce the absorbance reading difference by half.
   b. Reset the correct transmittance reading as in step 1.
   c. Continue to repeat steps a and b until agreement is reached as in step 3.
5. Turn the mode selector to TRANSMITTANCE and set 100.0 with the 100%T/zero A control.
6. Turn the mode selector to ABSORBANCE and observe the readout.

7. Turn the A/T calibration adjustment (shown in Figure 15) until the display reads .000. If the underrange sign (u) was displayed in step 6, turn the calibration control clockwise to obtain the .000 readout.
8. Repeat steps 1 through 7 to ensure that 39.9%T = .399A and 100%T = .000A, then proceed with step 9.
9. Turn the mode selector to ABSORBANCE. Set the SENSITIVITY switch to LO. Observe the display.
10. With the 100%T/zero A control, increase the absorbance readout to overrange .000 (which occurs just beyond 1.990 and equals 2.000A). If necessary, turn the wavelength dial lower than 340nm to decrease the detected energy and thus increase the absorbance readout.
11. Switch back to the transmittance mode. Turn the ZERO calibration adjustment (shown in Figure 15) until the display reads 01.0. (The display will continue to read 01.0 while you turn the adjustment about ¼ turn. The correct setting is the midpoint of this range.)

0%T Calibration (All Models)

1. Set the wavelength dial to 450nm. On digital models, set the mode selector to TRANSMITTANCE. With the 100%T/zero A control, set the display to read 100.0.
2. Install the occluder in the sample well and close the cover.
3. Turn the 0%T calibration adjustment (shown in Figure 16) until the display reads *exactly* 00.0.
4. Remove the occluder.

Concentration-Factor-Check Calibration (Digital Models Only)

1. Set the mode selector to ABSORBANCE. Press and hold the CONC. FACTOR CHECK button.

WARNING

This procedure involves a screwdriver adjustment inside the instrument chassis. High voltages are present within the chassis. Do not insert the screwdriver beyond the adjustment screw.

2. While pressing the CONC. FACTOR CHECK button, locate the concentration-factor-check calibration screw behind the third vent slot shown in Figure 17. With a screwdriver, turn the screw until the display reads *exactly* .100.

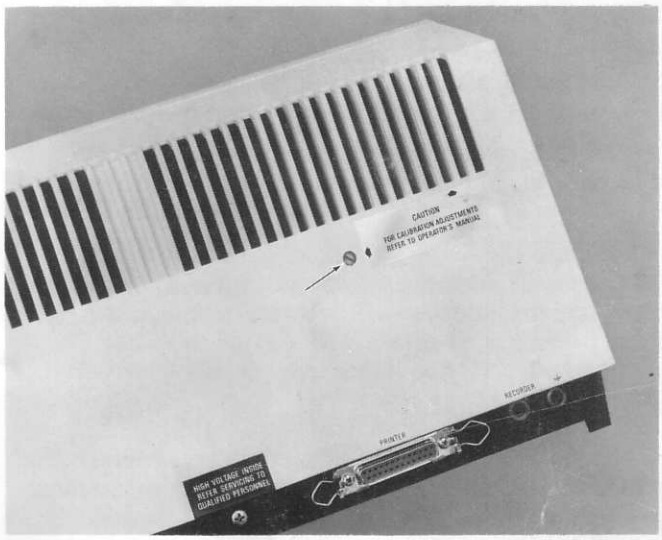


Figure 16. Location of 0%T Calibration Adjustment

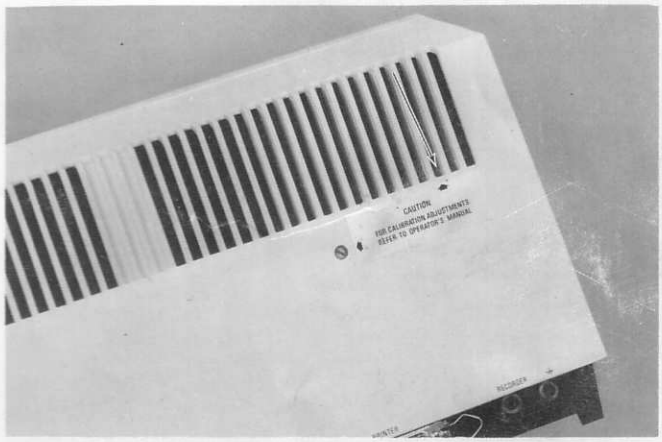


Figure 17. Location of Concentration-Factor-Check Calibration Adjustment

830

A = 444

T = 39.9

.45

398
374
24

252
251

READOUT DEVICES

Bausch & Lomb 10″ Strip Chart Recorder, 115V, Cat. No. 39-11-20; 220V, Cat. No. 39-11-30

Provides a permanent record of photometric values obtained during sample analysis. Also useful for monitoring a changing value as in time-rate enzyme procedures.

Strip Chart Recorder requires the Cat. No. 39-20-11 patch cord to connect the recorder to the instrument.

NOTE

Log-linear recorders such as those available from Houston Instrument Co. will permit direct recording in T, A, or C.

Digital-to-Analog Converter, Cat. No. 33-22-46

For use with model DV or UVD and strip chart recorder. Provides linear analog output in absorbance and concentration modes.

SAMPLE-HANDLING ACCESSORIES

Liquicell, Cat. No. 33-22-70

An aqueous liquid sampling system for use with model MV or DV spectrophotometer. Standard sample volume of 5ml can be adjusted within the range of 3-25ml. Cell pathlength is 3mm for analysis of high absorbance samples, such as found in the soft drink industry.

General Purpose Sample Compartment, Cat. No. 33-22-44

For use outside the main instrument; comes with lens system and multiple sample holder. For use with the MV (Cat. No. 33-22-42) and DV (Cat. No. 33-22-41). For use with UVD (Cat. No. 33-22-43) model, the sample compartment requires the Cat. No. 33-22-29 optical rail assembly.

For Use with General Purpose Sample Compartment

SEMI-MICRO/FLOW-THRU CUVETTE HOLDER, CAT. NO. 33-22-33
Required for using 10mm pathlength semi-micro or flow-thru cuvettes 45 to 48mm tall.

THERMO-REGULATED CUVETTE HOLDER, CAT. NO. 33-20-14
Water-jacketed multiple sample holder with three-position thermo-block maintains 10mm square cuvettes at temperature between 5 and 55°C while measurements are being made on sample requiring a temperature-controlled environment.

For Use with Main Instrument Sample Compartment

CUVETTE ADAPTER, CAT. NO. 33-22-08
Required for short cuvettes, 45 to 48mm tall.

SAMPLE COMPARTMENT COVER, CAT. NO. 33-22-07
For test tubes or cuvettes up to 102mm tall.

SPACER, CAT. NO. 33-17-98
For use with 2mm pathlength cuvettes, 45mm tall.

SPACER, CAT. NO. 33-17-97
For use with 5mm pathlength cuvettes, 45mm tall.

Replacement Test Tube Cuvettes Cat. No. 33-17-75

Selected, 10mm pathlength, optical glass, box of 12.

SPECTRONIC® STANDARDS, CAT. NO. 33-31-50

SPECTRONIC standards let you check spectrophotometer performance quickly, accurately, as part of normal laboratory quality control program. They make it as easy as loading a cuvette to check 0%T, wavelength accuracy, stray radiant energy, photometric accuracy/linearity, and optical alignment. The standards are individually tested and certified by Bausch & Lomb and traceable to NBS wherever applicable.

APPENDIX A

CHOOSING A READOUT MODE

TRANSMITTANCE MODE

All SPECTRONIC 21 spectrophotometers measure the relative amount of light transmitted, yielding results in transmittance. The transmittance mode is useful for calibration, stray radiant energy tests, and filter studies. Furthermore, very low concentrations can be measured with greater sensitivity in the transmittance mode. When the transmittance mode is used, the reagent blank is used to set 100%T, and the results for standard solutions and unknown samples are obtained as percent transmittance.

A standard curve may be constructed on semi-logarithmic paper by plotting the percent transmittance on the logarithmic axis vs. the concentration of known standard solutions on the linear axis. The best line is drawn through these points. The concentration of unknown samples may then be determined by locating the concentration value which corresponds to the percent transmittance of the unknown on the standard curves.

ABSORBANCE MODE

Usually, the operator desires results in absorbance for direct correlation to concentration by Beer's Law, $A = abc$. Results in percent transmittance can be converted to absorbance values by use of transmittance-absorbance conversion tables or by the formula $A = -\log_{10}T$. Results in absorbance may be plotted against the concentration of known standards on rectilinear graph paper. The best line is drawn through these points to construct a standard curve.

The concentration of unknowns can then be determined by locating on the standard curve the concentration value which corresponds to the absorbance of the unknown.

To eliminate T to A calculations, each model of the instrument provides conversion of transmittance values to absorbance:

Model MV has an absorbance scale marked with values corresponding to percent transmittance. The operator may simply read the absorbance scale and use these values to construct a standard curve as described above.

The digital models offer precise electronic conversion of transmittance to absorbance. When the absorbance mode is used, the reference blank is used to set .000A, and the results for standards and unknowns are obtained in absorbance. Results in absorbance may be related to concentration by Beer's Law, $A = abc$, if the absorptivity and pathlength are known, or by construction of a standard curve as described above.

Absorbance measurements are useful for kinetic studies and for reaction systems which do not obey Beer's Law and therefore have non-linear standard plots.

CONCENTRATION MODE

The digital models of the SPECTRONIC 21 spectrophotometer offer a more convenient readout, the concentration mode, which eliminates the necessity for constructing a standard curve. The instrument electronically converts results in absorbance to concentration units by multiplying the absorbance value by the slope of the standard curve ($1/ab$). Note that the concentration mode can be used only if the linearity of the standard curve has been verified for the test conditions used. These test conditions include wavelength, concentration range of interest, cuvette pathlength, and analytical procedure. Furthermore, the concentration mode can be used only if the standard curve has a positive slope (i.e., absorbance increases with concentration).

When using the concentration mode, first set the instrument in the absorbance mode and, using the reagent blank, set 000C. (A true reagent blank, not just reagent alone, should be used.) Using known standard solutions, introduce the $1/ab$ factor which converts absorbance to concentration, $c = 1/ab \times A$.

NOTE

It is not actually necessary to know the $1/ab$ factor because this factor is introduced into the instrument when the concentration adjust control is used to set the digital display to read the concentration of the standard. (See Operating Instructions for detailed instructions.)

CONCENTRATION-FACTOR-CHECK FEATURE

To verify that operating conditions do not vary between reagent batches or from day to day, use the concentration-factor-check feature as follows: After the concentration mode has been set up with standard solutions, press the CONC. FACTOR CHECK button and read and record the factor given on the digital display. Every time new standard solutions are used for the same test (such as for a new reagent batch or when setting up the instrument), press the CONC. FACTOR CHECK button and note the factor on the digital display.

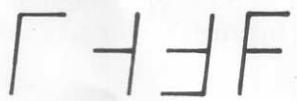
A change in the factor indicates a change in the slope of the standard curve due to variation in operating conditions. It is recommended that a standard always be used to set the concentration mode. The operator may choose, however, to set the blank to 000A or 000C, then switch to the concentration mode. With the CONC. FACTOR CHECK button pressed, the CONC. ADJUST knob may be used to set the pre-recorded factor into the instrument. Standards should be run for verification.

APPENDIX B

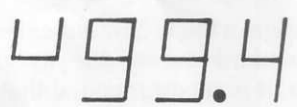
INTERPRETING THE DIGITAL READOUT ON A MODEL DV or UVD

The digital readout on a model DV or UVD provides useful information beyond displays of percent transmittance, absorbance, and concentration. The following information on readout interpretation is provided so you can more fully utilize the capabilities of your digital model instrument.

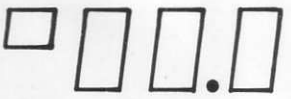
ALL MODES (TRANSMITTANCE, ABSORBANCE, CONCENTRATION).

Display example	Interpretation	
		This is what the display would look like if all segments of the four 7-bar characters and all the decimal point locations were lit at once. Real readings are made from different combinations of these 28 bars and 3 dots being off and on.
	Overrange	These are the permitted combinations of segments in the far left character. The small "o" and "u" using the upper half only mean "overrange" and "underrange." Readings are not valid when either of them is displayed.
	Underrange	
	One	
	Zero — 0	In-range readings may have no digit other than one in this location. (Zero is shown by all segments being off, since this is the far left place.)
		Rapidly changing nonsense displays may occur for two or three seconds after turning the POWER switch on or off.

TRANSMITTANCE MODE

Validity Status	Display example	Interpretation	
Underrange		-1%T or beyond	For calibration reasons, the region just below zero %T is made readable as shown. Around -1%T the display "locks up," and a further offset will not change the reading observed.
		-0.6%T	
		-0.1%T	

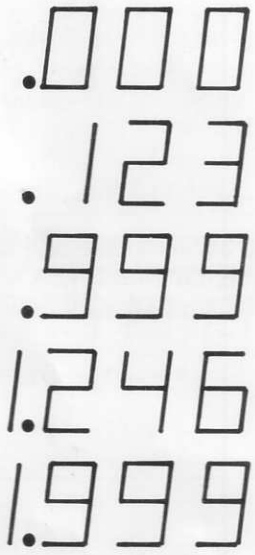
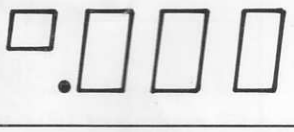
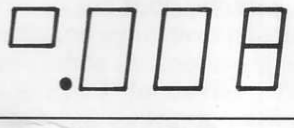
TRANSMITTANCE MODE (Con't)

Validity Status	Display example		Interpretation
In-range			When between zero and 199.9%T, the reading is straightforward. This is the usable range in the transmittance mode.
Overrange		200.0%T	When a %T reading of 199.9 is exceeded, the left character does not become a 2. Instead, it flags an overrange condition indicating invalid readings. At some reading around 220%T the readout "locks up"; additional light will not further increase the reading.
		205.8%T	
		220%T or more	

ABSORBANCE MODE

Validity Status	Display example		Interpretation
Underrange		-.001A	Negative absorbances are displayed in the manner shown so the user can easily approach a setting of .000A from this direction. The readout "locks up" at around -.010A; additional light would not change the reading thereafter.
		-.007A	
		-.010A or beyond	

ABSORBANCE MODE (Con't)

Validity Status	Display example	Interpretation	
In-range		When absorbance readings are between zero and 1.999A, the reading is straightforward. This is the usable range in the absorbance mode.	
Overrange		2.000A	When an absorbance reading of 1.999 is exceeded, the left character flags the overrange condition indicating invalid readings. At some reading around 2.200A, the readout "locks up" and will not change in response to further decrease in light levels.
		2.008A	
		2.200A or beyond	

CONCENTRATION MODE

The examples from the absorbance mode discussion apply almost without change to concentration too, including the fact that 1 is the only digit possible in the left-hand place. An important difference is that in the concentration mode you can move or omit the decimal point.